PATENT SPECIFICATION 1,045,972

DRAWINGS ATTACHED.

1,045,972

Date of Application and filing Complete Specification:
April 16, 1963. *No. 14870/63.*

Application made in Germany (No. Z9379 II/63c) on April 27, 1962.

Complete Specification Published: Oct. 19, 1966.

Index at Acceptance:—F2 D(2C1C, 2C3A, 2C3B, 2C4A, 2C4B1, 2C4B2, 2C4B3, 2D5, 2D7, 2D8, 7C6, 9A, 9B3, 9B4A, 9B5B, 9C1, 9D4, 9D8A, 9F2, 13C5, 13C7B, 13F, 13G1B, 13K2).

Int. Cl.:—F 06 h.

COMPLETE SPECIFICATION.

Improvements in or relating to Gear Boxes for Motor Vehicles.

We, ZAHNRADFABRIK FRIEDRICHSHAFEN AKTIENGESELLSCHAFT, of Friedrichshafen-on-the-Bodensee, Germany, a Joint-Stock Company incorporated under German Law, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The invention relates to gear boxes for motor vehicles, which consist of a multi-speed change-speed system of counter-shaft construction followed by an auxiliary range system.

Gear boxes for motor vehicles have been proposed which are composed of a countershaft gear box as main gear box and a subsidiary auxiliary range gear box. The auxiliary range gear box serves to double the utilisable number of gear speeds when the ratio of the additional gear stages are inserted as intermediate stages between the existing gear speeds. In this way the sequence of gear ratios is made closer.

In numerous applications, the auxiliary range gear boxes are constructed as countershaft gear boxes. In addition, a subsidiary auxiliary range gear box has been proposed which is constructed as epicyclic gearing with two sun wheels, double planet wheels, and a fixed internally toothed rim. This auxiliary range epicyclic gearing was used with countershaft gearing, but the sequence of the gear stages obtainable is not uniform.

Gear combinations consisting of main gearbox and auxiliary range gear box have hitherto required one shift lever for the main gear box and one for the auxiliary range gearbox. The operation of the shift levers of the two individual gear boxes however constitutes a great strain on the driver and in view of present day traffic density this can also constitute a danger in traffic. A "preselector shift" device has therefore already been proposed by which the control operation of one part of the gear box can be stored until it is simultaneously released on the operation of the other part of the gear box. In a practical form of this preselector shift device, a knob for the auxiliary range gear box, which could still just be reached by the fingers, is provided on the shift lever of the main gear box. This construction however can be used only for auxiliary range gear boxes with not more than two stages.

The present invention consists in a gear box for a motor vehicle, comprising a multi-speed countershaft gear box system and an auxiliary range gear box system, the auxiliary range gear box system being a simple epicyclic gear box system having a sun-wheel driven by the countershaft gear box system, an internally toothed rim, and a set of simple planet wheels between the sunwheel and the internally toothed rim, a shift device being provided by which the epicyclic gear box system can be shifted to reduction, direct drive, and reversal of direction of rotation by means of an auxiliary force under the control of shift movements of the shift lever for the countershaft gear box system which movements are additional to those required by the shift pattern of the countershaft gear box system.

It will be appreciated that the gear box according to the invention thus comprises a multi-speed countershaft gear box system and an epicyclic gear box system connected

as auxiliary range gearing and serving simultaneously for obtaining one or more reverse gear ratios. The auxiliary range gear box system can thus also serve as reversing gearing so that the vehicle can also be driven backwards with the ratio stages of the forward gear speeds. The ratio range of the main gear box system is one stage jump smaller than the ratio range of the epicyclic gearing. A feature of the gear box of the invention is that the auxiliary range gear box system is controlled by the same shift lever as is provided for the main gear box system. The shift elements of the auxiliary range gear box system are operated by additionally moving the shift lever to the side out of the neutral position. Through these shift movements a control apparatus for operating the auxiliary range gear box system is brought into operation.

The gear box of the invention has been developed in order to obtain fine-stage gearing which in particular can be used to improve the running performance of heavy commercial vehicles. Such a gear box permits more frequent running in a speed range in which fuel consumption is favourable. In addition, it was intended also to make it possible in commercial vehicles for all gear speeds to be synchronised by reasonable manual power without excessive expense for construction.

The auxiliary range gear box system is shifted in every case when in the countershaft gear box system all the shift sleeves are situated in the neutral position, so that only the mass of the driven shaft of the countershaft gear box system has to be accelerated or retarded, so that a low synchronising torque has to be supplied at the shift points of the auxiliary range gear box system.

In consequence of the small stage jump in the countershaft gear box system, the gear speed with maximum ratio can also be brought into synchronism, since with normal manual force and a reasonable torque of the shift lever a relatively low synchronising moment can be obtained. Under these conditions it is possible to synchronise the gear box over all gear speeds down to the first gear speed.

With the combination of a countershaft gear box system which has a relatively small ratio range with an epicyclic gear box system as auxiliary range gear box system, which despite the high ratio range can be of compact construction, a motor vehicle gear box is obtained which despite the features mentioned is smaller and lighter, for the same power transmission, than gear boxes of conventional construction the dimensions of which are determined by the ratio of the drive constant and of the first gear speed.

In order to make the invention clearly understood, reference will now be made to the accompanying drawings, which are given by way of example and in which:—

Fig. 1 is a diagram of an 8-speed gear-box with a planet-gear train, according to the invention;

Fig. 2 is a diagrammatic representation of a possible construction of an 8-speed gear box, according to the invention;

Fig. 3 is a longitudinal sectional view through an 8-speed gear box with sleeve shift, according to the invention;

Fig. 4 is a plan view, partly in section, of a pneumatic shift device for the auxiliary range gear box system of a gear box according to the invention, including a compressed air control; and

Fig. 5 is a front view of the device shown in Fig. 4.

Fig. 1 shows an 8-speed gear box of the invention which consists of a 4-speed countershaft gear box system C as main gearing and a simple epicyclic gear box system D. The epicyclic gear box system is here controlled by sliding the two shift sleeves 36 and 37 with a planet-gear train consisting of the internally toothed rim 30, planet wheels 31, and a cage 38. In the illustrated position "L", the epicyclic gear D acts as reduction gearing for the lower gear speeds. The drive is transmitted from the main gear box system through a sunwheel 33 to the planet wheels 31, which roll on the internally toothed rim 30 held fast by the claws g_1 of the housing G and the claws 37*a* of the shift sleeve 37, while a driven shaft 34 is drivingly connected with the cage 38 by its claws 38*a* and the claws 34*b* of the driven shaft 34.

In direct drive, the shift sleeves 36 and 37 are moved to the right in the position "S" so that the driving shaft 35 of the main gear box system C is connected direct to the driven shaft 34 through the shift sleeve 36 with its claws 36*a* splined on the sun wheel 33 and meshing the claws 34*a* of the driven shaft 34. If the planet-gear train 30—38 is displaced towards the left from the position shown to the position "R" so that the cage 38 is connected to the housing G through its claws g_2 and the claws 38*b* of the cage 38 and the internally toothed rim 30 is connected to the driven shaft 34 through claws 37*b* and 34*b*, the auxiliary range gear box system D acts as reversing gearing so that when necessary, four reverse speeds can be obtained with the four-stage countershaft gear box system.

In the case of the gear box of the invention shown in Fig. 2, the shift sleeves 60 and 63 have to be operated in each case in the same direction in order to obtain the different shift positions, so that the two

shift sleeves can be coupled together for the purpose of joint operation. On Fig. 2 the auxiliary range gear box F is shown in the shift position "L" for the slow gear speeds; by means of the non-rotary shift sleeve 60 splined to the housing the internally toothed rim 61 is connected to the housing, while the shift sleeve 63 splined on the driven shaft 64 connects the cage 62 to the driven shaft 64. In the left-hand shift position S the epicyclic gearing works direct, that is to say 1:1, because the shift sleeve 63 connects the output shaft 65 of the main gear box system C to the driven shaft 64. In the right-hand shift position R the driven shaft 64 runs in the opposite direction to the output shaft 65 of the main gear box system because the internally toothed rim 61 is operatively connected to the driven shaft 64 by the shift sleeve 63 and the cage 62 is connected to the housing by the shift sleeve 60. The two shift sleeves 60 and 63 are connected to move axially together by means of a disc 66.

Fig. 3 shows an 8-speed gear box of the invention in which the same 4-speed gear box C is used as main gear box system as in Figs. 1 and 2, while the auxiliary range gear box E is a preferred embodiment with a small space requirement and with a small weight.

In Fig. 3, 71 designates the driving or engine shaft the end of which carries the driving gear wheel 72 of the main countershaft gear box C. 73 is the driven shaft of the main countershaft gear box C, the front end of which is mounted in the end of the engine shaft 71. The rear end of the driven shaft 73 is supported in the part G of the housing by the bearing 75. On the shaft 73 the gearwheels 76, 77 and 78 are mounted to be freely rotatable. Between the gearwheels 76 and 77 the shift sleeve 79 is disposed, and between the gearwheels 72 and 78 the shift sleeve 80. By means of the shift sleeves 79 and 80 one of the two gearwheels is in each case connected so as to be rotationally rigid with the driven shaft 73. The gearwheels 72, 76, 77, 78 are in permanent engagement with the gearwheels 81, 82, 83 and 84, which are mounted to be non-rotational relative to the countershaft 85 which may be continued to the rear end of the gear box as power take-off shaft. At the output side, the front end of the driven shaft 74 of the auxiliary range gear box E is mounted in the end of the shaft 73. In addition the sunwheel 86 of the auxiliary range epicyclic gearing is mounted fast on the output end of the shaft 73. The associated internally toothed rim is designated by 87. The planet wheels 88 disposed between the sunwheel 86 and the internally toothed rim 87 are mounted rotatably on the journals 89, which are mounted fast at one end in the disc 90 and at the other end in the disc 91. A drum 97 surrounding the internally toothed rim 87 is connected fast to the disc 90. The shift sleeves 92 and 93, which are both connected together for axial movement by means of the sleeve 94 are provided for operating the auxiliary range epicyclic gearing.

With this countershaft gearing four gear speeds can be obtained in the known manner. If the ratios of this countershaft gear box system are selected in accordance with the sequence ϕ^0, ϕ, ϕ^2, ϕ^3, or ϕ^{-1}, ϕ^0, ϕ, ϕ^2, and the ratio of the subsidiary auxiliary range epicyclic gearing with ϕ^4, an eight-stage geometrically graduated gear speed range can be obtained with ϕ^0, ϕ, ϕ^2, ϕ^3, ϕ^4, ϕ^5, ϕ^6, ϕ^7 or ϕ^{-1}, ϕ^0, ϕ, ϕ^2, ϕ^3, ϕ^4, ϕ^5, ϕ^6. In order to obtain the four lower gears, the internally toothed rim 87 is held fast on the housing in the auxiliary range epicyclic gear box and the cage 91 is connected to the driven shaft 74. For this purpose the shift sleeve 92 and the shift sleeve 93 connected to it by the sleeve 94 are moved to the left. The non-rotary shift sleeve 92 has internal toothing 92*a*, by which it engages permanently in the external toothing 95*a* of the flange 95 connected to the part G of the housing. The shift sleeve 92 also has external toothing 92*b* by means of which it engages the internally toothed rim 87. On being moved to the left the shift sleeve 92 causes the toothed rim 87 first to be braked through the frictional engagement of the conical engagement surfaces of sleeve 94 with those of sleeve 96, and on further movement to the left the sleeve 92 engages the rim 87 by means of teeth 92*b*. At the same time the shift sleeve 93 slides to the left with its internal toothing 93*a* in the external toothing 74*a* of the driven shaft 74, so that the external toothing 93*b* of the shift sleeve 93 frees the internal toothing 96*a* of the sleeve 96. The external toothing 93*b* now engages by its entire tooth width in the internal toothing 91*a* of the cage 91, which in this way is joined fast to the driven shaft 74. In this shift position the planet wheels 88 driven by the sunwheel 86 roll over the stationary internally toothed rim 87 and the driven shaft 74 is driven with reduction by the cage 91.

In the middle position illustrated, the shift sleeve 93 engaging by its external toothing 93*b* connects the cage 91 to the sleeve 96 by means of the toothings 91*a* and 96*a*, so that the auxiliary range epicyclic gear box system runs as a block, since the sleeve 96 is at the same time joined fast to the internally toothed rim 87 through toothing as shown in Fig. 3.

If the shift sleeve 92 and with it the shift

sleeve 93 are moved into the right-hand end position, the external toothing 93*b* of the shift sleeve 93 frees the internal toothing 91*a* of the cage 91 and then only connects the internally toothed rim 87 to the driven shaft 74 through the sleeve 96. At the same time the external toothing 97*a* of the sleeve 97, which is joined fast to the disc 90 engages toothing 92*b* of sleeve 92. The disc 90 and sleeve 97 are now connected to the housing, that is to say are made fast, and in this case form the cage of the epicyclic gearing, which in this shift position acts as reversing gearing, since the planet wheels 88 driven by the sunwheel 86 act as intermediate wheels when the cage 90, 97 is braked, and through the internally toothed rim 87, the sleeve 96, and the shift sleeve 93 drive the driven shaft 74 in the opposite direction of rotation to the shafts 71 and 73.

The shifting of the auxiliary range epicyclic gear box system is effected by moving to the side the shift lever for the countershaft gear box system as more particularly described hereinbelow.

In Figs. 4 and 5 the shift bar for the first and second or fifth and sixth gear ratios is indicated by reference numeral 130. By means of the shift bar 131 the third and fourth or seventh and eighth gear ratios are controlled. Reduced ratio, direct drive and reverse gear ratio of the auxiliary range gear box are controlled by means of the shift bar 132.

A shift lever 120 is arranged for moving the shift bars into the desired position. A shift finger 140 is drivingly joined with the shift lever 120. Each of the shift bars 130 and 131 has a recess in which the shift finger 140 is selectively movable. A projecting portion 150*a* of an articulated rod 150 engages a recess of the shift bar 132. A compression spring 154 is provided between the rod 150 and a fixed part of the vehicle frame. Perpendicularly to the shift bars and on each side of these bars the control pins 141 and 142 are arranged for operating a compressed air valve 121 for changing to higher gear and for operating a compressed air valve 122 for changing to lower gear.

For shifting the auxiliary range epicyclic gear box E (Fig. 3) a working piston 125 is arranged in the cylinder 125*a*. A pipe 124 is arranged for connecting the valve 121 with the cylinder space above the piston 125, and the valve 121 is connected with the supply pipe 123 for compressed air. The cylinder space below the piston 125 is connected with the valve 122 by the pipe 124*a*, and the valve 122 is connected with the supply pipe 123*a* for compressed air.

The piston 125 is operatively connected through the articulated rod 150 and the shift bar 132 to the shift sleeve 92 for movement in longitudinal direction. The free end of the rod 150 is provided with a projection 153 which is adapted to cooperate with two stops 151 and 152 for respectively arresting the piston 125 in its central and upper position. A lug 155 of the rod 150 supports the latter against a fixed abutment when the shift finger 140 is positioned within the recess of the shift bars 130 and 131. The projection 150*a* of the rod 150 is, in the central position of the piston 125, aligned with the shift finger 140 when the latter is in its neutral position. In the upper position of the piston 125 (as viewed in Fig. 4) the shift sleeve 92 is moved into the left hand position (Fig. 3) and the auxiliary gear box E is shifted into the reduced ratio. In the central position of the piston 125—as shown in Fig. 4—the shift sleeve 92 is likewise in the central position—as shown in Fig. 3—and the auxiliary gear box E is shifted into the direct drive. If the piston 125 is moved into its lower position as hereinafter described, the shift sleeve 92 is moved into its right-hand position for reverse drive of the auxiliary range gear box E.

When the main gear box is in fourth gear (rail 131) and it is desired to shift to fifth gear (rail 130), the shift finger is first moved to neutral in the main box and is then moved to the right beyond the rail 130 as far as the adjacent longitudinal edge of the shift bar 132 and thus the compressed air valve 121 is opened, the compressed air flows through the pipe 124 into the cylinder space above the working piston 125 and moves the latter from its uppermist position which it occupies for reduced drive in the auxiliary gear, downwards until it is arrested by stop 151. Through the described movement of the working piston 125 the shift sleeve 92 in Fig. 3 is pushed into the central position shown. When the shifting of the auxiliary range gear box system E has been completed, the release valve 126 is opened by the cam 128, so that through the pipe 129 the piston 121*a* is loaded and presses the shift lever into the shift lane of the shift bar 130 which can then be shifted by the lever 120 into the next higher gear speed.

When the gear box is in the fifth gear and is to be shifted back, the driver must move the shift lever first into neutral as shown in Figs. 4 and 5 and then for a short time to the left beyond the rail 131, whereby the compressed air valve 122 is opened and through the pipe 124*a* loads the working piston 125 from below. The working piston 125 moves upwards from the central position into the position indicated by the dot-dash line 125 L and through the shift bar 132 moves the shift sleeve 92 shown in

Fig. 3 into the left-hand end position, so that the auxiliary range gear box system is shifted to a reduction ratio. On completion of the shift the release valve 127 is opened by the cam 128 this time and through the pipe 129*a* allows compressed air to flow into the cylinder space on the left of the piston 122*a*, which presses the shift lever into the shift lane 131 and hence indicates to the driver that the shift of the auxiliary range gear box system has been completed whereupon the lever can be operated to shift the rail 131 for fourth speed. In order to engage reverse gear, the shift finger 140 (Figs. 4 and 5) is moved to the right beyond its position for shifting the auxiliary range gear box to direct drive. In its movement the shift finger 140 presses against the projecting portion 150*a* and then pivots the adjacent part of the rod 150 clockwise so that its projection 153 is out of range of the stop 151 which hitherto prevented the piston 125 and with it the shift sleeve 92 from being pushed into the reverse gear position.

By opening the compressed air valve 121 the working piston 125 is pressed into the lowermost end position so that the shift sleeve 92 in Fig. 3 is pushed into the right-hand end position. The shift bar 130 can be mechanically coupled to the shift bar 132, so that the first gear in the main gear box system is also shifted when the shift sleeve 92 is pushed into the reverse gear position.

WHAT WE CLAIM IS:—

1. A gear box for a motor vehicle, comprising a multispeed countershaft gear box system and an auxiliary range gear box system, the auxiliary range gear box system being a simple epicyclic gear box system having a sunwheel driven by the countershaft gearbox system, an internally toothed rim, and a set of simple planet wheels between the sunwheel and the internally toothed rim, a shift device being provided by which the epicyclic gear box system can be shifted to reduction, direct drive, and reversal of direction of rotation by means of an auxiliary force under the control of shift movements of the shift lever for the countershaft gear box system which movements are additional to those required by the shift pattern of the countershaft gear box system.

2. A gear box as claimed in Claim 1, wherein the epicyclic gear box system has a ratio range which is greater by one stage jump than the ratio range of the countershaft gear box system.

3. A gear box as claimed in Claim 1 or 2, wherein a pneumatically operated auxiliary power plant is provided for the shifting of the auxiliary range gear box system.

4. A gear box as claimed in Claim 1, 2 or 3, wherein on both sides of a shift finger and at right-angles to the shift bars of the countershaft gear box system there is disposed a control pin each of which by its alternating displacement brings into operation the auxiliary force for shifting the auxiliary range gear box system, two release members, one for each of the two control pins, being provided and controlled by a displacing member of the shift device for pressing the shift finger into the other shift lane for the further shift into the next higher gear speed.

5. A gear box as claimed in any one of Claims 1 to 4, wherein for the shifting of the auxiliary range gear box system two shift sleeves are provided which are connected together by a sleeve for axial displacement.

6. A gear box as claimed in any one of Claims 1 to 5, wherein the countershaft is continued to the rear end of the gear box as a power take-off shaft.

7. A gear box for motor vehicles, constructed, arranged and adapted to operate substantially as hereinbefore described with reference to and as illustrated in any one of Figs. 1, 2 and 3, or Figs. 4 and 5 of the accompanying drawings.

H. A. L. VENNER,
Chartered Patent Agent,
1, Great James Street,
Bedford Row,
London, W.C.1.
Agents for the Applicants.

Abingdon: Printed for Her Majesty's Stationery Office, by Burgess & Son (Abingdon), Ltd.—1966.
Published at The Patent Office, 25 Southampton Buildings, London, W.C.2,
from which copies may be obtained.

1045972 COMPLETE SPECIFICATION
2 SHEETS This drawing is a reproduction of the Original on a reduced scale
Sheets 1 & 2

Fig. 1

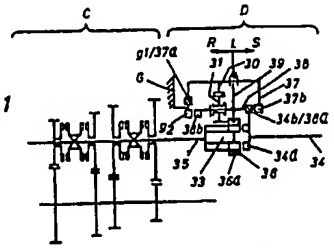


Fig. 2

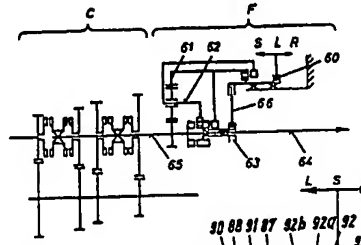


Fig. 3

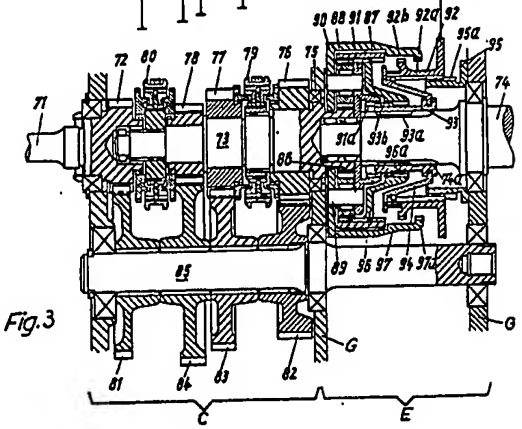


Fig. 4

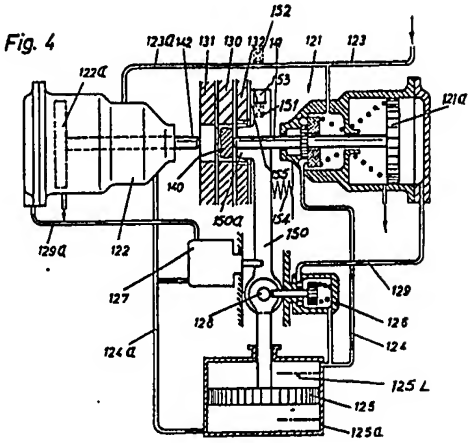
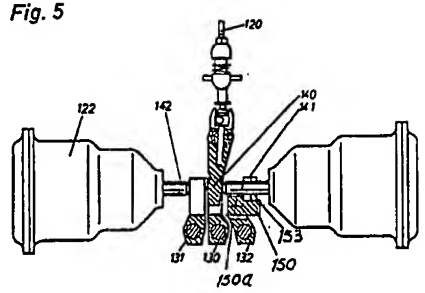
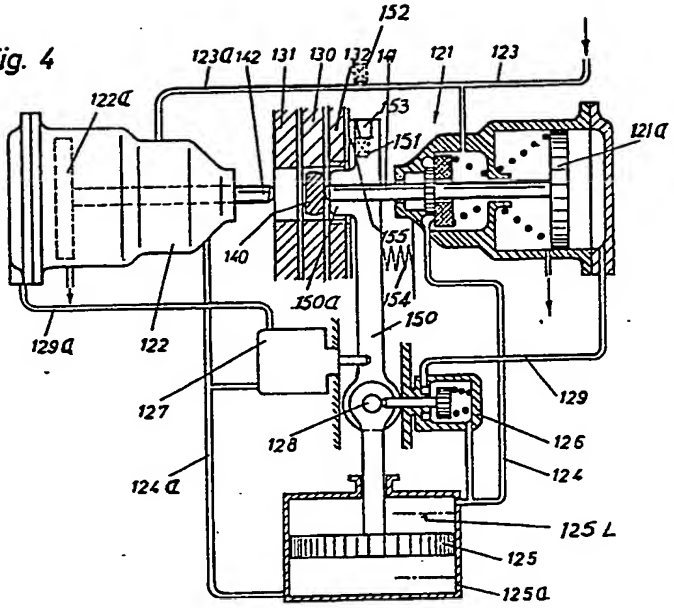


Fig. 5



1045972 COMPLETE SPECIFICATION
2 SHEETS *This drawing is a reproduction of the Original on a reduced scale*
Sheets 1 & 2

Fig. 4



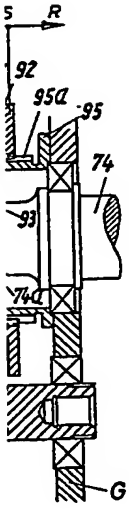
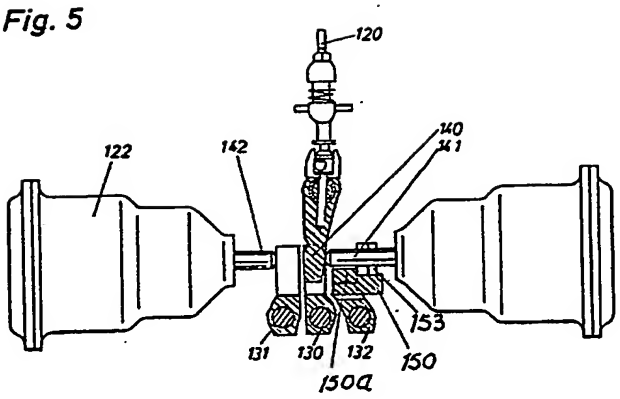


Fig. 5



This Page Blank (uspto)